# Journal of the Society of Arts.

*FRIDAY, JULY* 31, 1868.

## Announcements by the Council.

### HARVESTING CORN IN WET WEATHER.

The Essay by Mr. W. A. Gibbs, of Gillwell-park, Sewardstone, Essex, for which the Gold Medal of the Society and a prize of Fifty Guineas were awarded, is now ready. Published by Messrs. Bell and Daldy, York-street, Covent-garden, publishers to the Society of Arts; price one shilling, illustrated by woodcuts.

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## Proceedings of the Society.

### CANTOR LECTURES.

"ON FOOD." By DR. LETHEBY, M.A., M.B., &c.

LECTURE II., DELIVERED MONDAY, JANUARY 27.

*Comparative Digestibility of Foods—Functions of Different Foods.*

The phenomena of digestion are altogether of a physical and chemical nature; there is nothing whatever of a vital quality about them; for the comminuted food is brought successively under the influence of special solvents furnished by the saliva, the gastric juice, the pancreatic fluid, the biliary secretion, and the intestinal mucus; all of which are associated with a large volume of water. Digestion, indeed, as Berzelius remarked, is a true process of rinsing—the amount of fluid secreted into the alimentary canal, and again absorbed from it, being, according to the researches of Bernard, Bidder, and Schmidt, not less than three gallons in the twenty-four hours. The following, in fact, are the daily proportions of the several secretions and their solid constituents:—

| —— | lbs. | Solid Matter. | Active Principles. |
|---|---|---|---|
| | | grs. | grs. |
| Saliva .......... | 3·54 | 231 | 37 of ptyalin. |
| Gastric juice .... | 14·11 | 2,960 | 316 of pepsin. |
| Pancreatic fluid .. | 8·82 | 6,172 | 773 of pancreatin. |
| Bile ............ | 3·54 | 1,233 | 1,073 { of organic ferment. |
| Intestinal mucus .. | 0·47 | 46 | 28 of ditto. |
| Total ........ | 30·48 | 10,642 | 2,227 { of special solvents. |

All of which, by their special solutive actions on the several constituents of food, rob it of its nutritive quality, and carry it into the circulation.

Each of the fluids, so largely secreted into the alimentary canal, has its special functions.

The *saliva*, which is a secretion from many glands opening into the mouth, is a thin glairy liquid, of slight alkaline reaction, except while fasting; and containing about 1 per cent. of solid matter—half of which is a peculiar organic body, called *ptyalin*, and the rest is composed of chloride and phosphate of sodium, with a little carbonate and sulphocyanide. Ptyalin is a nitrogeneous substance, of the nature of diastase—the ferment, which in the vegetable converts starch into sugar, and hence it has been called *animal diastase* by Mialhe, who attaches great importance to it as the principal agent concerned in the digestion of starchy foods—one part of ptyalin, according to him, being capable of converting 8,000 parts of insoluble starch into soluble glucose. Saliva has no chemical action on fat, or fibrin, or albuminous bodies—its real functions being to lubricate the food for deglutition, to carry oxygen into the stomach, and to furnish a solvent for starch and tender cellulose. Those animals which feed chiefly on woody matters, as the beaver, have large salivary glands, and provision is made for a prolonged contact of the secretion with the vegetable tissue.

An artificial saliva may be obtained from seeds which have fermented, and in which the diastase is abundant. *Liebig's Extract of Malt* is an example of this; and Mr. Morson has taken advantage of the discovery of M. Mège Mouries, that the inner layer of bran contains a nitrogenous digestive principle called *cerealin*, of the nature of diastase, and has extracted it, and consolidated it with sugar, in a preparation which he has named *saccharated wheat phosphates*. Both of these are aids to the digestion of farinaceous matters.

*Gastric juice* is a secretion from the entire surface of the stomach. It is a transparent liquid, of a pale yellow colour, and of a saline and acid taste. It is much heavier than water (sp. gr. about 1,020), and it contains from 2 to 3 per cent. of solid matter—about 1·7 of which is a remarkable nitrogenous organic body, called by Schwann, its discoverer, *pepsin*. Its peculiarity is, that in the presence of an acid, it converts almost every description of albuminous and fibrinous matter into a soluble form of albumen, called by Lehmann, *peptone*, and by Mialhe *albuminose*. It differs from common albumen in many particulars—it is, for example, more liquid; it is not coagulated by heat, nor by weak spirit, nor by acids, nor by most mineral salts; it is not very prone to decomposition; and it is capable of *dialysis*, that is, of transudation through animal membrane, and, therefore, of absorption, which albumen is not. The digestive power of it is very great, for Wasmann found that an acid liquid containing only one part of it in 60,000 of the solution—that is, about one grain in a gallon, was capable of dissolving meat; and Lehmann ascertained that 100 parts of the gastric juice of a dog would digest 5 parts of coagulated albumen.

The nature of the free acid in gastric juice is somewhat doubtful; Lehmann, who has frequently examined it, says it is lactic acid, but Schwann asserts that he has often found free hydrochloric acid. It may be that the chlorides contained in the stomach are partially decomposed by lactic acid, especially during the process of analysis, and thus the hydrochloric acid may be accounted for. When the acid is in too large excess, the digestive action is abnormal, and so also when it is deficient; Lehmann states that the best proportion is when 100 parts of the gastric juice is just neutralised with 1·27 of potash.

Considering the importance of pepsin as a digestive agent, the preparation of it has become a common affair of trade. In France it is obtained from the stomach of the pig by carefully washing it, then scraping off the soft mucus membrane, rubbing it down with a little water, filtering, precipitating the foreign matters with acetate of lead, again filtering, and then precipitating the excess of lead with sulphuretted hydrogen, after

which it is allowed to stand, or it is warmed, to get rid of excess of sulphuretted hydrogen; it is then filtered once more, and after carefully evaporating to the consistence of syrup it is consolidated with dry starch. In this country it is prepared from the stomach of the sheep as well as of the pig, and we have our *pepsina ovis* and *pepsina porci;* besides which, the use of lead and sulphuretted hydrogen are avoided by precipitating the foreign matter with alcohol,—pepsin being soluble in weak spirit. On the lecture-table are specimens of Boudault's pepsin, as well as those of Mr. Morson, of London, Messrs. Turner and Co., and Mr. Claridge, of Warwick, all of which are also in operation, showing their relative digestive powers on animal fibrin.

The pepsin preparations on the table contain varying proportions of starch, as from 20 to 50 per cent.; but the digestive power of any specimen may be easily tested by putting a dose of the preparation into a small bottle with half an ounce of water, acidulating with 20 drops of hydrochloric acid, and then adding half a drachm of hard boiled egg chopped small, or the same weight of lean meat, or 120 grains of the fibrin of blood. On standing in a warm place at a temperature of from 100 to 110, the digestion should be complete in two hours. Tried in this manner, Dr. Pavy found, some time ago, that nearly all the preparations in common use were inert; not so, however, at the present time, for, as you will notice, digestion is proceeding rapidly.

I am told that the strongest pepsin is obtained from young healthy pigs which are kept hungry, and are then excited by savoury food which they are not allowed to eat while the influence of it is strong upon them, and the secretions are pouring out in expectation of the meal, the animals are pithed.

Pepsin, like diastase, is rendered inert by a temperature of from 120 to 130° Fah.; and, therefore, very hot drinks after a meal are hurtful.

*Pancreatic fluid* is a secretion from the pancreas or sweet-bread. Until recently its true digestive functions were not well determined. It is a colourless fluid of a gravity of 1,008 or 1,009. Like the saliva, it is generally a little alkaline, and it contains about 1·3 per cent. of solid matter, one-eighth of which is a nitrogenous organic substance of the nature of ptyalin or diastase, and is called *pancreatin.*

More than twenty years ago, Bernard proved, what Valentin had long before suspected, that the pancreatic fluid was concerned in the digestion of fatty matters; but he fell into error in supposing that its action was to saponify the fat, and to set glycerin free. Here is a specimen of glycerin and of lead-soap obtained from fat upon which the pancreatic fluid had previously acted, showing that saponification had not been effected. The true action of the pancreatic secretion is evidently to break up the large granules, and crystals and globules of oil and fat, into myriads of minute particles of from 1-3,000th to 1-15,000th of an inch in diameter. In this way the fat is emulsified and converted into a milky liquid, which mixes freely with water, and passes through the tissues of the intestines into the lacteals. We are indebted for this knowledge to Dr. Dobell, who had long been of opinion that the functions of the pancreas were important in certain diseases, and required elucidation. With the assistance of Mr. Julius Schweitzer, of Brighton, the then manager of the laboratory of Messrs. Savory and Moore, he made a large series of investigations into the properties of the pancreatic secretion, and he found that when the fresh pancreas (and best of the pig) is rubbed down in a mortar with twice its weight of hog's lard, it rapidly emulsifies it; and on adding about four or five times the bulk of water, and straining through muslin, there is obtained a thick milky liquid, of the consistence of cream, which gradually consolidates. If this be treated with ether, the pancreatised fat dissolves; and when the ether is separated by distillation, there remains the purified pancreatised fat, which is still miscible with water; in fact, when mixed with four or five parts of water it forms the creamy emulsion which is used dietetically and medicinally in doses of a teaspoonful at a time.

The properties of the pancreatic fluid have been well described by Dr. Dobell, in a paper recently read before the Royal Society of London; and it would seem that the fluid has not only the remarkable property of emulsifying oil and fat, and so rendering them capable of absorption, but it has also the power of dissolving starch by converting it into glucose. In this respect its action is like that of saliva, but it is much more energetic; for in its fresh state, one part of the pancreas will dissolve eight parts of starch, and even after it has emulsified fat it will dissolve two parts of starch. It is, therefore, a powerful agent of digestion, in so far as fat, and starch, and young cellulose are concerned, but it has little or no action on albuminous substances.

I am indebted to Dr. Dobell and to Mr. Morson for the specimens of *pancreatin* and *pancreatized* fat upon the table. The first of these preparations is obtained by treating the fresh pancreas with water, and carefully evaporating the solution to the consistence of syrup, and then consolidating it with the flour of malt. Perhaps the dried pancreas, powdered and mixed with malt, would be a stronger preparation.

The *Bile* is a complex liquid, consisting of biliary acids (*taurocholic*, *glycocolic*, &c.) in combination with soda. Its reaction is slightly alkaline, and it contains about 14 per cent. of solid matter, not less than 12 of which are organic.

The true function of the bile is unknown; perhaps it aids in neutralizing the acid peptones from the stomach; perhaps, also, in emulsifying fat; and it may be that it helps the digestion of starchy foods. Lehmann thinks it is a rich residuum from the manufacture of blood globules in the liver, and that it is secreted into the alimentary canal, only to be reabsorbed into the blood. Mr. Lee, also, is of opinion, from his examination of the fœtal liver, that it separates a highly nutritious substance from the portal blood, which is elaborated in the intestines. Its functions, however, are manifestly obscure.

Lastly, the *intestinal secretion* which is thrown out along the whole course of the small intestines, is, according to the researches of Bidder and Schmidt, a powerful agent of digestion; for it combines the activity and digestive power of all the other secretions—starch, fat, and albuminous substances being all equally well digested by it.

The food, therefore, coming into contact with these special solvents, and being copiously drenched with fluid, gives up its nutritive constituents. Admirable, however, as this provision is for the digestion of food, a considerable portion of useful matter passes through the bowel unchanged; for cellulose, starch globules, and muscular fibre are common constituents of sewage. Dr. Lyon Playfair says that in the case of an adult man, with good digestion, 1-12th of the nitrogen of the food passes away with the excreta, and others have computed it at an 8th. In a dry state the fæces of man contain about 6·5 per cent. of nitrogen, and in the fresh state, 1·7. In Ranke's experiments, it was ascertained that the nitrogen in the fæces was to that in the urine as 1 to 12·5. Much of this is, doubtless, derived from the secretions which have done the work of digestion, and have thus become effete; indeed, Dr. Marcet is of opinion that the alvine discharges are chiefly composed of the residuum of albuminous substances which have been secreted into the bowel for the purposes of digestion. In ordinary individuals they amount to from 4 oz. to 5·5 oz. a-day—(Wehsurg says 4·6 oz.; Liebig, 5·5 oz.; Lawes, 4·2 for a middle-aged adult, and 6·2 for a person over 50—the mean amount for adult males being 4·2 oz., and for adult females 1·3 oz.); and when calculated in a dry state they amount to about 1·1 oz. daily. It would seem, however, that when indigestible and irritating food is used, the quantity of fæcal matter is increased, as if the food was hurried through the intestines without under-

going digestion. At the Wakefield Prison, for example, it was found that when brown bread, containing bran, was given to the prisoners, the weight of the fæces was 7 oz. per head daily; and the same fact has been observed at the Coldbath-fields Prison.

With this general account of the digestive function of the different secretions discharged into the alimentary canal, we are prepared to inquire into the digestibility of different alimentary substances.

*Nitrogenous* or *proteinaceous*, or *albuminous substances*, which constitute the leading articles of diet, are evidently digested by the gastric juice and the intestinal mucus. In the former case they are converted into acid peptones, of which, according to Lehmann, there are several varieties, as *albumino-peptones*, *fribrino-peptones*, *caseino-peptones*, *gelatino-peptones*, &c., according as they are derived from albumen, fibrin, casein, gelatin, &c., and of these substances the fluid form of albumen is most easily converted; then coagulated albumen; then fibrin; then casein; and, lastly, the derivatives of albumen, gelatin, chondrin and cartilage. The tegumentary forms of albumen, as hair, wool, feathers, &c., being entirely indigestible. Here is an example of the indigestibility of hair—it is a ball of it, obtained from the alimentary canal of a cow, and has come from the calf which the cow has a habit of licking. Serpents and other animals that swallow their prey entire, digest the soft tissues and bones, but they disgorge the hair and feathers untouched.

It is difficult to speak of the comparative digestibility of different nitrogenous foods; for the well-known experiments of Dr. Beaumont on the Canadian with a fistulous opening in the stomach, and even experiments made in bottles with pepsin, do not represent the full and natural conditions of the process: at the present time there are, no doubt, great differences in the digestibility of different animal substances. Dr. Beaumont found, in his inquiries, that soused pigs' feet and soused tripe were the most digestible of all foods, and that boiled tendon of meat was the least digestible. The following, in fact, are the times given by him for the chymification of different animal foods:—

| Articles of diet. | How cooked. | Time of chymification. H. M. |
|---|---|---|
| Pigs' feet (soused) | Boiled | 1 0 |
| Tripe (soused) | Do. | 1 0 |
| Eggs (whipped) | Raw | 1 30 |
| Salmon trout | Boiled | 1 30 |
| Venison steak | Broiled | 1 30 |
| Brains | Boiled | 1 45 |
| Ox liver | Broiled | 2 0 |
| Codfish (cured dry) | Boiled | 2 0 |
| Eggs | Roasted | 2 15 |
| Turkey | Boiled | 2 25 |
| Gelatine | Do. | 2 30 |
| Goose | Roasted | 2 30 |
| Pig (sucking) | Do. | 2 30 |
| Lamb | Broiled | 2 30 |
| Chicken | Fricasseed | 2 45 |
| Beef | Boiled | 2 45 |
| Do. | Roasted | 3 0 |
| Mutton | Boiled | 3 0 |
| Do. | Roasted | 3 15 |
| Oysters | Stewed | 3 30 |
| Cheese | Raw | 3 30 |
| Eggs | Hard boiled | 3 30 |
| Do. | Fried | 3 30 |
| Beef | Do. | 4 0 |
| Fowls | Boiled | 4 0 |
| Do. | Roasted | 4 0 |
| Ducks | Do. | 4 0 |
| Cartilage | Boiled | 4 15 |
| Pork | Roasted | 5 15 |
| Tendon | Boiled | 5 30 |

It is doubtful, indeed, if cheese or tendons are ever digested except in small quantity; and it is evident, from these experiments, as I shall hereafter explain, that cooking has considerable influence on the digestibility of food.

It is a curious problem why the stomach does not digest itself, seeing that it belongs to the class of most easily digestible substances, as tripe. Hunter explained it by referring the protective power to the vital force, for when dead the stomach digests itself in common with the food contained in it; but Bernard's and Pavy's experiments have proved that this is not the right explanation, for if the legs of living frogs, or the ears of living rabbits, are introduced into the stomach of a dog through a fistulous opening in the side, they digest like other proteinaceous substances. Liebig supposed that the protective power was in the thick mucus which lined the stomach, but Pavy denuded a part of the inner walls of a dog's stomach, and found that the tissue did not digest, but, on the contrary, quickly healed, and he is of opinion that the protective power is in the alkaline condition of the blood, which circulates so freely through the capillaries vessels of the stomach during digestion.

*Starchy substances* and *cellulose* are digested by the ptyalin of the saliva, and the pancreatin of the pancreatic fluid, as also by the animal diastase of intestinal mucus. The solution is effected by the conversion of the starch and cellulose into a low form of sugar, called *glucose*, which is freely absorbed into the circulation, or becomes changed into lactic acid, that serves so important a function in the digestion of nitrogenous matter. The time necessary for the digestion of different vegetable substances, as determined by Dr. Beaumont, is as follows:—

| Articles of diet. | How prepared. | Time of chymification. H. M. |
|---|---|---|
| Rice | Boiled | 1 0 |
| Apples (sweet and mellow) | Raw | 1 30 |
| Sago | Boiled | 1 45 |
| Tapioca | Do. | 2 0 |
| Barley | Do. | 2 0 |
| Apples (sour and mellow) | Raw | 2 0 |
| Cabbage with vinegar | Do. | 2 0 |
| Beans | Boiled | 2 30 |
| Sponge cake | Baked | 2 30 |
| Parsnips | Boiled | 2 30 |
| Potatoes | Roasted | 2 30 |
| Do. | Baked | 2 33 |
| Apple dumpling | Boiled | 3 0 |
| Indian corn cake | Baked | 3 0 |
| Do. do. bread | Do. | 3 15 |
| Carrot | Boiled | 3 15 |
| Wheaten bread | Baked | 3 30 |
| Potatoes | Boiled | 3 30 |
| Turnips | Do. | 3 30 |
| Beets | Do. | 3 45 |
| Cabbage | Do. | 4 0 |

It would be seen from this that the time of digestion is in proportion to the amount of cellulose or woody tissue in the food. No doubt there is a more complete solution of these matters in the small intestines, where the pancreatic fluid and intestinal mucus, aided by the alkaline condition of the fluids, exert the greatest actions on them, but it is very doubtful whether hard cellulose and woody matter are at all digested by man. Even in the case of the pig, whose digestive powers are singularly active, it is thought by Messrs. Lawes and Gilbert, from their experiments on the fattening of animals, that there is little or no digestion of these substances; and, under any circumstances, a very prolonged contact with the secretions is necessary for their digestion. Raw starch will pass a

considerable distance along the alimentary canal of man without much change, and it is only towards the end of the small intestines that the starch granules undergo marked disintegration. Those animals which feed entirely on vegetables have always a contrivance for keeping the food for a long time in contact with the secretions. It occurs as the paunch in ruminants, the crop in birds, the large cœcum in rabbits and other rodentia, and as the long alimentary canal of all of them; but even then a large portion of the vegetable tissue passes through the bowels unchanged. Cooking, grinding, and otherwise disintegrating the tissue helps considerably in the digestion of it.

*Gum* and *pectin* are probably not digested at all, for as they are unchanged by contact with the secretions, and are incapable of dialysis or absorption, they must pass through the alimentary canal without serving any purpose in nutrition.

*Fatty matters* are digested by the emulsifying action of the pancreatic fluid; and by being thus broken up into extremely minute globules they are freely admitted into the lacteal vessels; in fact, the emulsified globules of fat are seen covering the villi of the intestines, penetrating their tissues, pervading the subjacent cellular bodies, and thus entering the lacteals; and, no doubt, the peristaltic action of the intestines contributes largely to this emulsifying process.

*Saline substances* are generally soluble in water, and are therefore easily absorbed, but when this is not the case, as with the earthy phosphates, they are attacked by the acid constituents of the gastric juice.

And here I may remark that the great aids to digestion are:—

1st. Proper selection of food, according to the taste and digestive power of the individual.

2nd. Proper treatment of it as regards cooking, flavouring and serving it.

3rd. Proper variations of it, both to its nature and treatment, so that the appetite may not fail.

4th. Exercise, warmth, and a genial disposition.

*Functions of food.*—Although much attention has been directed to this important subject, viz., the immediate and remote functions of food, yet it must be admitted that the difficulties of the question have not been surmounted, and that we are hardly able to particularise the phenomena which are incidental to its transformations. We can see clearly enough that its ultimate destiny is the manifestation of force—the letting loose of the cosmical agencies which were bound up in it—when, by undergoing oxydation, it returns more or less completely to its original forms—carbonic acid, water, and ammonia; but how and where these changes occur, and what are the subsidiary phenomena, and concurrent functions, besides those of common motion and animal heat, are as yet almost unknown to us. Nor are we sufficiently acquainted with the special attributes of the principal constituents of food, as the albuminous, the fatty, the farinaceous, the saccharine, and the saline; for although the well-known opinions of Liebig, with regard to the dynamic or force-producing functions of the nitrogenous or plastic elements of food, and of the thermotic or respiratory powers of the carbonaceous have been generally received, yet there are abundant reasons for believing that both of these classes of food may perform exactly the same functions in respect of the development of force; and, again, it is more than probable that the nitrogenous, or plastic constituents of food may, like the carbonaceous, be oxydised and consumed in the living body without ever entering into the composition of tissue. In these respects, therefore, there are great points of divergence from the views of Liebig.

Looking, however, at the proximate elements of food, it may, perhaps, best serve our present purpose if we inquire generally into the several functions of water, albuminoid compounds, fatty substances, farinaceous and saccharine matters, and mineral salts.

1st. *Water* is, unquestionably, of great physiological value, for as much as 75 per cent. of the muscular tissue of the animal frame is composed of it; and of the 20 lbs. of blood which an average-sized adult contains in his body, about 15½ lbs. are water. It is computed, also, that not less than 30 lbs. of fluid ebb and flow daily from the blood and alimentary canal by secretion and absorption. Bidder, indeed, estimates that about 28·6 lbs. of chyle and lymph are carried daily by the thoracic duct alone into the circulation—a quantity of fluid that amounts to about one-fifth of the entire weight of the adult human body; and, then, with regard to the excretions, we find that rather more than a pound of water is exhaled daily by the breath, about a pound and three-quarters by the skin, and not less than two pounds and three-quarters by the kidneys, making altogether about five pounds and a-half per adult daily.

These results indicate the importance of water in the functions of the animal body. It serves indeed to dissolve the food and carry it into the circulation; to effect the distribution of it throughout the system; to dissolve effete matters, as the metamorphosed constituents of worn-out tissues, and so convey them out of the body; to establish the chemical activity which is necessary for nutrition and decay; to combine mechanically with the tissues and lubricate them, so that they may perform their functions; and lastly, to evaporate by the air-passages and skin, and thus maintain the proper temperature of the body.

2nd. The second constituents of our food—namely, *albuminous*, *nitrogenous*, or *plastic matters*, were once, and until very recently, thought to have the sole function of constructing and repairing the muscular parts of the body; and having so entered into the composition of tissues, their oxydation and decay were attended with manifestations of force which were the working powers of the animal machine. "We see," says Liebig, "as an immediate effect of the manifestation of mechanical force, that a part of the muscular substance loses its vital properties,—its character of life; that this portion separates from the living part, and loses its capacity for growth and its power of resistance. We find that this change of properties is accompanied by the entrance of a foreign body (oxygen) into the composition of the muscular fibre; and all experience proves, that this conversion of living muscular fibre into compounds destitute of vitality, is accelerated or retarded according to the amount of force employed to produce motion. Nay, it may safely be affirmed, that they are mutually proportional; that a rapid transformation of muscular fibre, or, as it may be called, a rapid change of matter, determines a greater amount of mechanical force; and conversely, that a greater amount of mechanical motion (of mechanical force expended in motion), determines a more rapid change of matter." He further remarks that "the amount of azotized food necessary to restore the equilibrium between waste and supply is directly proportional to the amount of tissue metamorphosed," that "the amount of living matter, which in the body loses the condition of life, is, in equal temperatures, directly proportional to the mechanical effects produced in a given time." That "the amount of tissue metamorphosed in a given time may be measured by the quantity of nitrogen in the urine;" and "that the sum of the mechanical effects produced in two individuals in the same temperature, is proportional to the amount of nitrogen in their urine; whether the mechanical force has been employed in voluntary or involuntary motions; whether it has been consumed by the limbs, or by the heart and other viscera."

These are the generalizations of Liebig, and they go to show, not only that the dynamical action of the animal body depends wholly on the transformation of muscular tissue, and may be measured by the quantity of nitrogen excreted as urea; but also that no oxydation of nitrogenous matter can take place until it has passed from the condition of food to tissue, and has thus be-

come organized. According to this view, the mechanical force of the human machine is derived entirely from its own combustion, and not from the oxydation of matters contained in the food.

For some time past there have been suspicions that this view of the case is not correct; and the doubts of physiologists have been strengthened by the circumstance that great labour might be performed for a short period without the use of a nitrogenous diet; and that while there was always a relation between the quantity of nitrogen in the food and that excreted as urea, there was no such relation between the dynamical actions of the body and the proportions of urea. Moritz Troube, in fact, asserted in 1861, after a careful examination of the subject, that all muscular force was derived from the oxydation of fat and hydrocarbons, and none from the oxydations of tissue. Haidenham, in 1864, arrived at a similar conclusion; and Donders was likewise of opinion that tissue transformation would not account for all the force of the animal body.

The hypothesis of Liebig has been further shaken by the investigations of Dr. Edward Smith, who has shown that the proportions of nitrogen in the urine does not increase with exercise, although the amount of carbonic acid exhaled by the lungs does. But the most convincing proof of the fallacy of the hypothesis was furnished in 1866 by the experiments of Dr. A. Fick, the Professor of Physiology at Zurich, and Dr. J. Wislicenus, the professor of chemistry.

On the 29th of August of that year they prepared themselves for an ascent of the Faulhorn, one of the Bernese Alps, which rises 6,417 feet above the Lake of Brientz. For seventeen hours before the journey, they took nothing in the way of solid food but cakes composed of starch, fat, and sugar; and on the following morning, at half-past five o'clock, they began the ascent, choosing the steepest of the practical paths from the little village of Iseltwald on the Lake of Brientz. At twenty minutes past one in the afternoon their journey was accomplished without fatigue, and from that hour to seven in the evening they remained at rest in the hotel at the top of the mountain. During the whole of that time (a period of thirty-one hours) they took no other food but the non-nitrogenous biscuits; but at seven o'clock they had a plentiful meal of meat, &c.

The urine was collected at three intervals, namely:—

1st. From 6 o'clock, p.m. of the 29th to 5 a.m. of the 30th; and this they called the *night urine.*

2nd. From 5 a.m. of the 30th to 1.20 p.m.; and this they called the *work urine.*

3rd. From 1.20 p.m. to 7 p.m.; and this they called the *after-work urine.*

4th. From 7 p.m. on the 30th, to the morning of the 31st; and this they called the *night urine.*

All these were analysed for nitrogen, and the results were as follows:

| | Grains of Nitrogen Secreted by | | | |
|---|---|---|---|---|
| | Fick. | | Wislicenus. | |
| 1st. Night urine ........ | 106·7 | | 103·1 | |
| 2nd. Work urine ........ | 51·1 | 88·6 | 48·3 | 85·6 |
| 3rd. After work urine .... | 37·5 | | 37·3 | |
| 4th. Night urine ........ | 74·3 | | 82·5 | |

So that not only were they able to perform the work without a nitrogenous diet, but the quantity of nitrogen excreted was less during the work than before or after. Even calculated at the hourly rate of excretion, it stands thus:—

| | Grains of Nitrogen Hourly Excreted. | |
|---|---|---|
| | Fick. | Wislicenus. |
| During 1st night ........ | 9·72 | 9·41 |
| During time of work .... | 6·33 | 6·02 |
| During rest after work.... | 6·17 | 6·17 |
| During 2nd night after work | 6·94 | 7·87 |

The work which they had performed was estimated thus:—Fick weighed 145·5 lbs. avoirdupois, and Wislicenus 167·5 lbs.; and as they had ascended 6,417·5 feet, it is clear that Fick had raised 933,746 lbs. one foot high (145·5 × 6417·5), and Wislicenus 1,074,931 lbs. 167·5 × 6417·5); so that for an expenditure of muscular tissue, represented in the one case by 88·6 grains of nitrogen, and in the other by 85·6 grains, the foregoing amounts of work had been done. Now, as 1 of nitrogen represents 6·4 of dry muscular tissue, it is evident that Fick had consumed 567 grains of muscle, and Wislicenus 547·8 grains.

At the time of the experiment, the thermotic and mechanical powers of these proportions of flesh were not accurately known, but they have been since determined in a very careful manner by Dr. Frankland, who finds that when pure dry lean of beef, albumen, and urea are completely oxydised in a proper apparatus, they develope the following amounts of heat and mechanical force:—

| | Lbs. of water raised 1° Fahr. | Lbs. lifted one foot high. |
|---|---|---|
| 10 grains of pure dry beef.. | 13·1 | 10,083 |
| " " " albumen.. | 12·8 | 9,878 |
| " " " urea .... | 0·6 | 436 |

In considering the mechanical power of muscular tissue, it must be remembered that it is never completely oxydised in the animal body, but it is changed into carbonic acid, water, and about one-third of its weight of urea, so that the potential energy of muscle is not so great as in the preceding results. Calculated, indeed, according to the proportions of urea formed, the tissues of Fick and Wislicenus were capable of the following amounts of physiological energy:—

| | Fick. | Wislicenus. |
|---|---|---|
| Quantity of muscle consumed .... | 567·0 grs. | 547·8 grs. |
| Actual energy if fully burnt .... | 571,706 ft.-lbs. | 552,347 ft.-lbs. |
| Available energy, deducting the urea .......... | 563,466 ft.-lbs. | 544,386 ft.-lbs. |
| Work actually done | 933,746 ft.-lbs. | 1,074,931 ft.-lbs. |

So that, in the case of Fick, 370,280 foot-pounds of work and, in the other, 530,545 foot-pounds are unaccounted for. But this is not all, for, besides the mere labour of ascending the mountain, there were the movements of respiration, and the beating of the heart, and other motor actions, to be added to the work actually done.

Now each beat of the heart is estimated as equal to a lift of 4·61lbs. one foot high; and it is considered from Dondor's well-known investigations that the work of an inspiration is nearly the same—namely, 4·54lbs. a foot high. Fick says that during the ascent his pulse beat at the average rate of 120 a minute, and his respirations were 25. The beating of his heart, therefore, during the 5½ hours actually taken in the ascent was equal to 182,556 lbs. lifted a foot high; and the respiration to 37,455 lbs.

If the internal labour, or, as it may be called, the *opus vitale* of Wislicenus was in proportion to his bodily weight, as compared with Fick's—that is, as 7 to 6, then the ascertainable work done, was to the power of the muscle consumed, as follows:—

| | Fick. | Wislicenus. |
|---|---|---|
| | Ft.-lbs. | Ft.-lbs. |
| Work of ascending the mountain | 933,746 | 1,074,931 |
| Work of circulation | 182,556 | 212,982 |
| Work of respiration | 37,455 | 43,698 |
| Total ascertainable work | 1,153,757 | 1,331,611 |
| Actual energy of the consumed muscle | 563,466 | 544,386 |
| Energy unaccounted for | 590,291 | 787,225 |

From which it appears that taking only the three factors of ascertainable work—namely, external labour, circulation and respiration, and disregarding other unascertainable motor actions of the body, which are estimated by many as greater than all the rest, the work actually performed exceeds the energy of the oxydised muscle by more than as much again.

It may be said, and truly, that these experiments of Fick and Wislicenus were of too short a duration to afford an opportunity of ascertaining whether the oxydised muscle was not afterwards excreted; but the recent researches of Dr. Parkes on the elimination of nitrogen by two healthy men (soldiers) in the prime of life, during a period of seventeen days, and under different conditions of diet and exercise, have shown that, although the results are not altogether accordant with those of Fick and Wislicenus—yet the conclusions are certainly born out, that a non-nitrogenous diet will sustain the body during exercise for a short time, and that exercise produces no notable increase in the nitrogen of the urine. On the contrary, the amount of urea is actually less during work than at a period of rest; and he thinks that the muscle, instead of oxydising, and, therefore, losing its substance during labour, actually appropriates nitrogen and grows—its exhaustion being dependent, not so much on its decay, as on the accumulation of the oxydised products of hydro-carbon, as lactic acid, &c., in its tissue, which require rest and time for their removal. That some decay of the muscle takes place there can be no doubt; for, as Dr. Parkes observes, "although it is certain that very severe exercise can be performed on non-nitrogenous diet for a short time, yet it does not follow that nitrogen is unnecessary. The largest experience shows, not only that nitrogen must be supplied, if work is to be done, but that the amount must augment with the work. For a short period the well-fed body possesses sufficient nitrogen to permit muscular exertion to go on for some time without a fresh supply; but the destruction of nitrogenous tissues in these two men is shown by the way in which, when nitrogen was again supplied, a large amount was retained in the body to compensate for previous deprivation." It would seem, too, from the great exhaustion of the men on the second day of a non-nitrogenous diet, that their muscles and nerves were becoming structurally impaired, and that if the experiments had been continued for a third day there would have been a large diminution in the amount of work. The work which they actually performed on a non-nitrogenous diet of starch and butter, in the form of biscuits and arrowroot, was walking exercise of 23·76 miles the first day, and 32·78 the second. The first day's work occupied, with intervals of rest, about ten hours and three-quarters, and it was done without fatigue; but the second day's work took twelve hours, and the last thirteen miles were accomplished with great fatigue. Calculated according to Haughton's formula (that walking upon a level surface is equal to lifting 1-20th of the weight of the body through the distance walked), the labour in the two days was, for—

| | S. Weighing with clothes 162·4 lbs. | T. Weighing with clothes 124·2 lbs. |
|---|---|---|
| The first day | 1,018,676 ft.-lbs. | 779,062 ft.-lbs. |
| The second day | 1,405,397 „ | 1,074,817 „ |
| Total work | 2,424,073 „ | 1,853,879 „ |
| Total nitrogen excreted | 529·16 grains. | 492·46 grains. |
| Equal to muscle oxydized | 3,386·92 „ | 3,151·74 „ |
| The energy of which (minus urea) is | 3,267,361 ft.-lbs. | 3,040,483 ft.-lbs. |

The amount of nitrogen excreted during the time of actual exercise was only about half the above; and, calculated in this way, it would only account for about two-thirds of the labour-force. The results, therefore, prove that although the basis for the calculations of Fick and Wislicenus was too narrow for accurate deductions, yet the mechanical force of the oxydised muscle is not sufficient to account for external and internal work; and the conclusion is that, in the above experiments, the motive power of the muscles was not derived from their own oxydation of non-nitrogenous matters.

The researches of Dr. Edward Smith throw additional light on the subject, for he ascertained that the amount of carbonic acid exhaled by the lungs was in proportion to the actual work performed.

| | |
|---|---|
| During sleep it was at the rate of | 293 grs. per hour. |
| When lying down and approaching sleep | 355 „ „ |
| In a sitting posture | 491 „ „ |
| When walking two miles an hour | 1,088 „ „ |
| When walking three miles an hour | 1,552 „ „ |
| And when working at the treadmill | 2,926 „ „ |

It is highly probable, therefore, that the largest amount of muscular force is derived from the hydro-carbons of our food; not that the nitrogenous matters of it may not also be a source of power; but there is no necessity, as Liebig supposes, for their being previously constructed into tissue. The experiments of Mr. Savory, in fact, show that rats can live and be in health for weeks on a purely nitrogenous diet, and it is nearly certain that under these circumstances the nitrogenous matters are mostly oxydised without entering into the composition of tissue. This, as I have said, is the main point of divergence from the hypothesis of Liebig; and it is further indicated by the fact that the amount of nitrogen excreted is not in proportion to the work done, but to the quantity of it in the food, even when there is no muscular exertion.

That the chief functions of nitrogenous matters is to repair tissue, there can be no doubt, for animals kept on a purely carbonaceous diet quickly lose weight, and at last die from a disintegration of tissue; but it is equally certain that the nitrogenous constituents of food have other offices to perform. A daily diet of 2lbs. of bread contains enough nitrogen to supply the mechanical wants of the system, but it will not maintain life. There is required an addition of animal food to render it sufficient for this purpose; and indeed the instincts and habits of the human race show, beyond all question, that a comparatively rich nitrogenous diet is necessary for the proper sustenance of life; and it is very probable that it assists the assimilation of the hydrocarbons. In this way it may help in the development of force without itself contributing directly to it; and this may serve to explain the fact, that there is a relation between the amount of nitrogen contained in the food and the labour value of it. Carnivorous animals are not only stronger

and more capable of prolonged exertion than herbivororous, but they are also fiercer in their disposition, as if force were superabundant. The bears of India and America, says Playfair, which feed on acorns, are mild and tractable, while those of the polar regions, which consume flesh, are savage and untamable; and taking instances of people—the Peruvians whom Pizarro found in the country at its conquest, were mild and inoffensive in their habits, and they subsisted chiefly on vegetable food; whilst their brethren in Mexico, when found by Cortes, were a warlike and fierce race, and they fed for the most part on animal diet. The miners of Chili, who work like horses, also feed like them, for Darwin tells us that their common food consists of bread, beans, and roasted grain. The Hindoo navvies also who were employed in making the tunnel of the Bhore Ghat Railway, and who had very laborious work to perform, found it impossible to sustain their health on a vegetable diet, and being left at liberty by their caste to eat as they pleased, they took the common food of the English navigators, and were then able to work as vigorously. Abundant examples of this description—some of which will be further discussed as we proceed, may be cited in proof of the direct relation of plastic food to mechanical work; but there is no proof that this material must first form tissue before its dynamical power can be elicited.

It is, however, a remarkable fact that all forms of nitrogenous food have not the same nutritive value; the glutinous matters of barley and wheat, though almost identical in chemical composition, have very different sustaining powers. It is the same with muscular flesh and artificially prepared fibrin and gelatine. Magendie found that dogs fed solely, for 120 days, on raw meat from sheep's heads, preserved their health and vigour during the whole of the time; but more than three times the amount of isolated fibrin, with the addition of much gelatine and albumen, were insufficient to preserve life.

We may conclude, therefore, that although the main functions of nitrogenous matters are to construct and repair tissue, yet they have manifestly other duties to perform of an assimilative, a respiratory, and force-producing quality which are far from being understood. What do we know, indeed, of the actual *modus operandi* of the nitrogenous ferments—ptyalin, pepsin, pancreatin, &c., which are secreted so abundantly into the alimentary canal; or of the conjugate nitrogenous compounds which are present in the bile? and how far have we advanced in interpreting the functions of the nitrogenous constituents of tea, coffee, maté, guarana, cocoa, &c., which the instincts of mankind in every part of the globe have evidently chosen for some physiological purpose? The same may be said of the crystalline nitrogenous matters of soup—as creatin, creatinin, inosic acid, &c., which can hardly be regarded as foods, although they have powerful sustaining properties. But enough of this for the present; and before leaving this part of the subject, I would direct attention to the fact, that nitrogenous matters when oxydised in the animal body never yield up the whole of their potential energy, for, by being converted into urea, which is the chief product of their decay, there is at least a seventh part of their power lost in the secretion. It may be that this is a necessity arising out of the circumstance that if they were completely oxydised in the animal body and converted into carbonic acid, water, and nitrogen, the last-named gas would be unable to quit the system, because of its insolubility in the animal fluids.

(*To be continued.*)

# Proceedings of Institutions.

Yorkshire Union of Mechanics' Institutes.—Bradford Mechanics' Institute.—The acquisition of 1,000 yards of land at Bowling-green, for the erection of a new building for the Mechanics' Institute, being now an accomplished fact, the directors draw attention to the circumstance that thirty-six years ago the Institute began its career in rented rooms, and with funds not exceeding £100. From that time the Institute has continued to grow, and its success "has been its extremity." The present building has long been inadequate to meet its wants, and, encouraged by liberal offers from several quarters, the directors have entered on a scheme involving an expenditure of £25,000,—£12,500 for land, and £12,000 for the proposed new building. The directors state that "taking the most liberal estimates of the resources which will arise from the sale of the present building, and the appropriation of certain portions of the new erections so as to yield a profitable return, a sum of not less than £12,000 must be raised by the friends of popular education in Bradford;" and they think that if scope be given to its operations, "this healthy and vigorous Institution will rise to the rank of a people's college for Bradford, worthy of the town, and ready to do its part in the advanced education upon which, happily, the nation has now set its heart."

## EXAMINATION PAPERS, 1868.

(*Continued from page 623.*)

The following are the Examination Papers set in the various subjects at the Final Examination held in April last:—

### GEOMETRY.

THREE HOURS ALLOWED.

1. Show how to bisect a given rectilineal angle. How would you do this graphically?

2. If from a point within a triangle straight lines be drawn to the extremities of the base, the sum of these lines shall be less than the sum of the sides of the triangle, but they shall include a greater angle.

3. Parallelograms upon the same base, and between the same parallels, are equal to one another.

4. Describe a parallelogram that shall be equal to a given rectilineal figure, and have an angle equal to a given rectilineal angle. Does not this include the last proposition of Euclid, book ii.? Explain fully.

5. If a straight line be divided into two equal and also into two unequal parts, the squares of the two unequal parts are together equal to twice the square of half the line, and twice the square of the line between the points of section.

6. From a given point draw a straight line to touch a given circle.

7. Upon a given straight line describe a segment of a circle which shall contain an angle equal to a given rectilineal angle.

8. Show how to describe an equiangular and equilateral pentagon in a given circle.

9. If the sides of two triangles, about each of their angles, be proportionals, the triangles shall be equiangular.

10. If four straight lines be proportionals, the rectangle contained by the means is equal to the rectangle contained by the extremes.

11. The rectangle contained by the diagonals of a quadrilateral figure inscribed in a circle is equal to both the rectangles contained by the opposite sides.

12. Every solid angle is contained by plane angles, which together are less than four right angles.

Problems.

1. If the area of a square and a triangle be equal, the perimeter of the triangle will be greater than the perimeter of the square. Prove this. Generalise this proposition.

2. Given an angle, the side opposite to it, and the difference of the other two sides of a triangle; construct the triangle geometrically.

3. If from the three angles of a triangle lines are drawn to the middle points of the opposite sides, prove that these lines meet in a point, and show that the sum of the

squares of the lines from the common point of concourse to the angles of the triangle is equal to one-third of the sum of the squares of the sides of the triangle.

4. If from any point in a circular arc perpendiculars be drawn upon the bounding radii, the distance of their feet is a fixed quantity.

5. If two circles intersect, their common chord will bisect the common tangent of the two circles. Prove this. What analogous proposition can be established with respect to two circles which do not intersect?

6. Two circles (1) and (2) touch one another, and another circle (3) is described which touches both and includes them, having its centre in the line which passes through the centres of (1) and (2). Let a common tangent be drawn to (1) and (2), find the relation between the radii of circles which are drawn to touch (1) (3) and the tangent, and to touch (2) (3) and the tangent.

7. Of all polygons having equal perimeters and the same number of sides, the equilateral polygon has the greatest area.

8. With a given radius, describe a circle which shall touch two given circles. Show when the problem is impossible, when there is only one such circle, and when there will be two such circles.

9. Show geometrically that the rectangle contained between two straight lines is a mean proportional between their squares.

10. Two equal circles are drawn intersecting in A and B; a third circle is drawn with centre A, and radius less than A B, cutting the former circles in D and C; show that B, D, C are in the same straight line.

## MENSURATION.

THREE HOURS ALLOWED.

1. The area of a triangle is 39 ft. 117·45 in., and its altitude 7·75 ft.; find the base.

2. Find by duodecimals the area of a triangle, the sides of which are 4 ft. 3 in., 5 ft. 8 in., and 7 ft. 1 in.

3. How much paper, $\frac{3}{4}$ths of a yard wide, will be required to paper a room which is 19 ft. 11 in. long, 14 ft. 7 in. wide, and 11 ft. 3 in. high? And how much will it cost at $2\frac{1}{4}$d. a yard?

4 Find the side of a square which costs £33 16s. $10\frac{1}{2}$d. paving at 10d. a yard.

5. A wall measures 100 ft. 10 in. in length, and 15 ft. 7·2 in. in height, and is $4\frac{1}{2}$ bricks thick;—how many rods of brickwork does it contain?

6. The diameter of a circular window is 3 ft. 7 in.; what will be the cost of glazing it at 1s. 6d. a foot?

7. Prove that the area of a circle $= \frac{1}{2}$ circumference $\times$ radius. What ratio does the circumference of a circle bear to its diameter?

8. The paving of a semicircular court, at 3s. 4d. a yard, costs £115 10s.; find the length of the circular part.

9. An iron cylindrical bar is 2 yards long and 6 inches in circumference; find its volume and weight; the weight of a cubic foot of the iron being 7,500 ounces.

10. Find the surface of a right cone, the base of which is 3 inches in diameter and the height 4 inches.

11. Find the volume of a pyramid when its base is a triangle.

12. Given the areas of the two ends of a frustum of a pyramid and its height, find the solid content.

13. Given that the volume of a cone is equal to one-third of the cylinder with the same base and height, prove that the volume of a sphere is two-thirds of the circumscribing cylinder.

## TRIGONOMETRY.

THREE HOURS ALLOWED.

1. Find sec. A when $\frac{1 + \cos. 2A}{1 - \sin. 2A} = \tan. A.$

2. What is the ratio between 1° 25′ English and 1° 25′ French?

3. Investigate formulas for the sums and differences of the sines and cosines of two angles.

4. Find A when

(1.) $\text{Cos. } A - \cos. 2A = \sin. 3A.$
(2.) $\text{Cos. } A + \cos. (120 + A) + \cos. (120 - A) = 0.$
(3.) $\text{Sin. } 7A - \sin. A = \sin. 3A.$

5. Given the ratios of the sines of the angles of a triangle, find the angles.

6. The elevation of a tower on a horizontal plane is observed; on approaching $a$ feet nearer, the elevation is 45°, and $b$ feet nearer still, it is the complement of the first angle; show that the height is $\frac{ab}{a-b}$

7. A B C D is a quadrilateral inscribed in a circle; $\angle DAC = \alpha$, $\angle CAB = \beta$, $\angle DBA = \gamma$; $AB = c$, then $CD = \frac{c \sin. \alpha}{\sin. (\alpha+\beta+\gamma)}$

8. Solve the equation,
$$2 + \cot.^2 x = 3 \sec.^4 x - \tan.^2 x.$$

9. Find the radius of the circle which passes through the vertex A of the triangle A B C, and touches the base B C at its bisection D.

10. If A, B, C, be the angles of a triangle A B C, show that $\cos. \frac{1}{2}A + \cos. \frac{1}{2}B$ is greater than $\cos. \frac{1}{2}C$.

11. If the sides of a triangle be $a + b$, $a + c$, and $b + c$, its area $= \sqrt{(a + b + c)\, abc}$.

12. If a triangle be formed of the perpendiculars A D, B E, and C F, from the angles A, B, C, of the triangle A B C on the opposite sides, and if $A_1$ $B_1$ $C_1$ be the angles of the new triangle, $A_1$ being opposite A D.
$$2(a \cos. A_1 + b \cos. B_1 + c \cos. C_1) = \frac{bc}{a} + \frac{ac}{b} + \frac{ab}{c},$$
$a$, $b$, $c$, being the sides of the original triangle.

13. If a degree of longitude at the equator be 69 miles, what will be the length of a degree in latitude 60°?

14. The sides and angles of the polar triangle are respectively the supplements of the angles and sides of the original triangle.

15. Prove the formulas:—

(1.) $\text{Cos. } c = \cos. a. \cos. b + \sin. a. \sin. b. \cos. C.$
(2.) $\text{Cos. } a. \sin. b = \cos. b. \cos. c + \cos. A. \sin. C.$

16. Prove the theorems:—

$\text{Cos. } \frac{1}{2} c. \cos \frac{1}{2} (A + B) = \cos \frac{1}{2} (a + b) \sin. \frac{1}{2} C.$
$\text{Sin } \frac{1}{2} c. \cos. \frac{1}{2} (A - B) = \sin. \frac{1}{2} (a + b) \sin. \frac{1}{2}$

## CONIC SECTIONS.

THREE HOURS ALLOWED.

SECTION I.—GEOMETRICAL CONICS.

1. What is a Cone? Show that an ellipse, a parabola, and a hyperbola may be each projected into a circle. What lines will be projected into diameters of the circle perpendicular to each other?

2. Define a tangent. Show that in a parabola the sub-tangent is equal to twice the abscissa, whether the axes are rectangular or not.

3. Prove that the perpendicular from the focus on the tangent of a parabola intersects the tangent in the line that touches the curve at the vertex. Hence show that $SZ^2 = SP \times SA$.

4. If two chords of a parabola intersect one another the rectangles contained by these segments are as the parameters of the diameters which bisect the chords. What is the corresponding theorem in the ellipse?

5. Define an ellipse, and draw a tangent to it from any point on the curve.

6. Prove the following properties of an ellipse:—

(1) $CN \times CT = CA^2$
(2) $SP \times S'P = CD^2$

7. If QV is any ordinate to the diameter PCP′ of an ellipse, and CD is conjugate to CP, then
$$QV^2 : PV \times VP' :: CD^2 : CP^2$$

8. Prove that the difference of the focal radii of a point on the hyperbola is equal to the transverse diameter.

9. If through any two points P and P′ of a hyperbola a line is drawn intersecting the asymptotes in Q and Q′ prove that PQ = P′Q′. What form does this theorem take when QQ′ is a tangent?

10. Define the circle of curvature and chord of curvature. What is the value of the chord of curvature passing through the focus in the parabola?

SECTION II.—ANALYTICAL CONICS.

11. Find the equation to the line passing through $(a, b)$ and perpendicular to $bx + ay - ab = 0$.

12. Determine the condition that three given points should be on the same straight line.

13. Find the equation to the system of circles which pass through two given points, and show analytically that the centres all lie in the straight line bisecting at right angles the line joining the two given points.

14. What is the equation of the tangent of the ellipse? and prove that that at the extremity of the latus rectum intersects the axis in the point of intersection with the directrix?

15. Prove analytically the theorems contained in 2, 3, 6, 8, 9 of the preceding section.

16. What is a locus? Prove that the locus of the point of intersection of a tangent to a rectangular hyperbola with the perpendicular on it from the centre is the curve whose equation is $r^2 = a^2 \cos 2\theta$.

17. Show that the equation to the ellipse may be put under the form $x^2 + y^2 = c^2$.

(*To be continued.*)

## Fine Arts.

THE SCULPTURE GALLERIES OF THE LOUVRE.—Those who visit Paris this autumn will find a great change in the lower floor of the museum of the Louvre. The portion of the building known as the apartments of Anne of Austria, which have for many years been devoted to Grecian and Roman sculptures, have been completely restored and embellished, and are now approached through a fine gallery in the new Louvre, in which is a curious collection of statues and busts of Roman Emperors, principally from the Campana museum, and some other interesting antiques. Between the two galleries is a smaller one, in which a large number of specimens of sculpture, of the Roman and old French schools, are now seen to great advantage, and they possess much interest, not only in an artistic, but also in a historical point of view. The second gallery referred to is that in which the fine electrotype reproductions of Trajan's Column were recently to be seen. They have been removed, and we are not aware whether they are now exhibited. On the upper floor, the small room, which formerly contained the charming collection of engraved and jewelled crystal and other cups and ornaments now seen to great advantage in the noble Galerie d'Apollon, has been devoted to eight frescoes, by Luini, or of some artist of his school, which were purchased in Italy a short time since. Scarcely a month passes without some marked improvement in the Louvre. The galleries devoted to French art have been greatly increased during the last two years, and they will be still further extended next year, by the removal of the Salle des Etats to that part of the great gallery which joins the Tuileries.

DECORATION OF RAILWAY STATIONS IN FRANCE.—The directors of the Lyons and Mediterranean Railway have set an admirable example to other administrators of railways. They have commissioned M. Desplèchins, who is also engaged on the decoration of the new Opera-house of Paris, to paint for their station four pictures, nine mètres long by five mètres in height, representing the four great towns on the line, namely, Paris, Montpellier, Marseilles, and Geneva. The large walls of many railway-stations offer a fine field for decorative painting, and it is somewhat strange that the opportunity has not been taken advantage of before.

STATUE TO PALISSY THE POTTER.—A statue of Bernard Palissy has been executed for the town of Saintes, his birth-place, by M. Taluer, and the inauguration is announced to take place on the second of the coming month of August.

STATUE OF THE LATE PAINTER INGRES.—Out of the large number of models sent in for this competition, the Academy of the Beaux Arts of Paris has not judged any one deserving of the first prize, which would carry with it the right to execute the work, but it has awarded the second prize, of 1,000 francs, to M. Maillet; and the third, 600 francs, to MM. Falgniere, sculptor, and Boitte, architect, for their joint production.

## Manufactures.

MANUFACTURE OF PAPER IN ITALY.—The paper manufacture, which at one time was so flourishing in Italy, has, by the introduction of machinery, and the reduction in the export of rags, been to some extent superseded by foreign manufacturers. The following are the imports and exports of rags from 1862 to 1865:—

| Years. | Imports. | | Exports. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| | Quintals. | Francs. | Quintals. | Francs. |
| 1862.... | 10,864 | 217,000 | 85,865 | 1,717,000 |
| 1863.... | 17,895 | 358,000 | 103,787 | 2,076,000 |
| 1864.... | 12,592 | 253,000 | 71,983 | 1,440,000 |
| 1865.... | 12,205 | 243,000 | 78,814 | 1,576,000 |
| Average | 13,389 | 268,000 | 85,112 | 1,702,000 |

The following shows the actual state of the paper trade at the present time:—

| Provinces. | Manufacturers. | Workmen. | Rags consumed. | Products Obtained. | | |
|---|---|---|---|---|---|---|
| | | | | Reams. | Quintals. | Value. |
| | | | quintals. | | | |
| Piedmont and Liguria ...... | 180 | 3,000 | 95,000 | ... | 72,200 | 7,000,000 |
| Lombardy ...... | 90 | 2,000 | 70,000 | 650,000 | ... | 4,500,000 |
| Venetia ........... | 50 | 850 | 20,000 | ... | 15,000 | 1,400,000 |
| Parma ........... | 7 | 140 | 2,500 | 40,000 | ... | 180,000 |
| Modena ........... | 16 | 200 | 2,034 | 1,700 | 1,413 | 1,490,000 |
| Romagna, Umbria, & Marches | 60 | 1,250 | 17,500 | 15,000 | 11,600 | 1,670,000 |
| Tuscany ......... | 71 | 1,200 | 40,000 | ... | 30,000 | 1,800,000 |
| Neapolitan Provinces ......... | 62 | ... | 120,000 | ... | 80,000 | 10,000,000 |
| Totals ...... | 536 | 8,640 | 367,034 | 706,700 | 210,213 | 28,040,000 |

Of the 180 manufacturers in the former kingdom of Sardinia, 106 are situated on the coast in the Ligurian provinces. These manufacturers employ about 3,000 persons, and consume 95,000 quintals of rags, and produce annually 72,200 quintals of paper of every quality. Besides the production of 15,000 quintals hand-made paper, of the value of 1,600,000frs., for which there is a great demand, as being of excellent quality for making cigarettes, there are 70 small paper-mills in the province of Genoa, producing 11,000 quintals of paper for packing. There are also three manufacturers of machine-made paper, which consume 10,040 quintals of rags, and produce 7,800 quintals of paper. One of the

most important paper-mills is that at Serravalle-Sesia, in the province of Novara; this establishment employs more than 250 workmen. There are two large paper-making machines and 15 water wheels; the production of paper is 35,000 quintals, and 45,000 quintals of rags are annually consumed at this establishment. Sienna, Lucca, and Pistoja are the principal seats of the paper manufacture in Tuscany. The paper mills of Signor Cini, at San Marcello, are, perhaps, the most important. There are two large paper machines of English make; the paper made is of endless lengths, and 1·20 metre in width (48 inches). The average yearly production is estimated at 7,000 packages of white paper, valued at 800,000frs. (£36,000). In the district of Lucca there are 57 paper-mills, with 115 vats and 126 machines, employing 950 workmen. The production is estimated at 27,085 quintals of paper of every kind, valued at 1,445,800frs., and the consumption of rags is estimated at 35,265 quintals; 12,000 quintals of paper from this province are exported to the East and America. The paper manufacture forms an important branch of industry in the Neapolitan provinces, and the water-courses of the Leri and Fibreno in the territory of Sora, Arpino, and Isola, the Rapido al St. Elia and Cassino, and the Melfe, at Atina, offer considerable advantages for the establishment of paper-mills. The hand paper-mills at Amalfi, Majuri, Vietri, and Atripalda, are also advantageously situated as regards water supply. In the nine principal establishments in the province of Sora there are 20 machines for making continuous paper. The production amounts to 50,000 quintals, for the value of 6,250,000frs. The other 53 are hand paper-mills, with 137 vats, producing upwards of 30,000 quintals of paper, which may be valued at 3,750,000frs. yearly. The consumption of rags for paper-making in the Neapolitan provinces is estimated at 120,000 quintals. Although the production of paper has diminished of late years on account of foreign competition, it still exceeds the home consumption. The average imports of this article are 10,176 quintals for the value of 2,117,000frs., and the exports amount to 21,000 quintals for the value of 4,400,000frs. Since 1862, it will be seen that the imports have gradually diminished, whilst, on the other hand, the exports have increased:—

*White and Coloured Paper.*

| Years. | Imports. | | Exports. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| | Quintals. | Francs. | Quintals. | Francs. |
| 1862.... | 11,571 | 2,407,000 | 17,024 | 3,540,000 |
| 1863.... | 11,534 | 2,399,000 | 20,674 | 4,300,000 |
| 1864.... | 9,907 | 2,061,000 | 19,926 | 4,145,000 |
| 1865.... | 7,691 | 1,600,000 | 26,761 | 5,556,000 |
| Average | 10,176 | 2,117,000 | 21,096 | 4,385,000 |

The same proportion exists between the imports and exports of packing and blotting papers, the average being 1,018 quintals, at the value of 77,000frs.; imports and the exports amount to 11,127 quintals, for the value of 846,000frs. The exports of pasteboards amount to 429 quintals, for the value of 60,000frs.

## Commerce.

Havre Maritime Exhibition.—A large public dinner was given in the Cirque International last week, by the exhibitors in Class 7, to afford the general public an opportunity of testing their different products exhibited, served in various ways, and in the best style, by professed cooks. Farinaceous products, breads and biscuits, tapiocas, Patés d'Italie, rices, maizena, Borwick's baking powder, and other articles, proved what excellent supplies could be furnished to mariners. Dried vegetables of all kinds and others preserved fresh, such as asparagus, peas, &c., were found to be excellent. The preserved meats and fish were also of superior quality; the former included the extracts of meat of Coleman and the Australian Meat Company, with kangaroo, furnished by the last-named, which made excellent soups. Dried meats of all kinds, whether smoked, spiced, salted, or simply sun-dried, were found most savoury. Morton, of London, and other exhibitors supplied excellent salmon, herrings, lampreys, tunney, lobsters, mackarel, &c., whilst patés and saucissons aux foie gras, truffles, showed that other delicacies were to be had. Banbury beer, Hay's Scotch whisky, and West India rum were also furnished; whilst of preserved milks, choice cheeses, preserved fruits, and confectionery there was no lack. The chairman of the exhibition, and the various foreign consuls and ship-owners who were present were much pleased with the general arrangements and the quality of the articles submitted to their notice. The "menu" was, perhaps, one of the most remarkable on record, from the great variety and excellence of the dishes, made with apparently unpromising materials, while the receipts were published in full for the benefit of the company. The whole arrangements for organising and carrying out successfully this dinner were made by Messrs. J. M. Johnson and Sons, the London concessionaires for the exhibition.

## Colonies.

Farming in New South Wales.—A Sydney paper of the 21st May says:—"In consequence of the continued drought, which is common to all parts of the colony, farming operations are at a complete standstill. From all quarters the news received is of anything but a cheerful nature. The farmers who lost their wheat last year in consequence of the rust, have now to anticipate the failures of their maize through the drought. Every district in the colony seems to be in the same condition. It is said that in some parts the farmers are unable to prepare their land for wheat, and that if rain does not come soon the winter will be a very gloomy one. The land is scorched, the meadows are parched, and the streets dusty, whilst in many parts the nights are cold and frosty. The squatters complain very much of the want of water and of feed for their flocks. Amongst the new expedients to which the squatters are turning thir attention, is that of boiling down horses. Some persons have started in this particular line of business, and it is said to be a very profitable trade. They obtain permission to run in all the wild horses they can find, and having secured them with much labour and difficulty, they remunerate themselves by boiling the animals down. These wild horses are often a great nuisance to the squatters, who are glad to get rid of them on these terms."

Property in the City of Melbourne.—The amount of the assessment on the rateable property within the city boundaries for the present year was £653,984. The total amount of the assessment in the seven preceding years was:—

| | |
|---|---|
| 1867 | £613,655 |
| 1866 | 595,265 |
| 1865 | 569,483 |
| 1864 | 550,998 |
| 1863 | 555,708 |
| 1862 | 581,774 |
| 1861 | 652,676 |

There has been an increase of about 1,500 houses since 1861.

Revenue of South Australia.—In the year 1867, there was a nèt decrease on the general revenue amounting to £233,480, as compared with that of 1866, the total income of the two years being £716,294 and

£949,774 respectively. In 1865, the general revenue amounted to £1,089,124, and in 1864 it amounted to £775,837, so that the income of the State is dwindling away year by year, rendering our present position, especially viewed in connection with our responsibilities, one of no small concern. A good test of the condition of the community is the amount of money paid into the Custom-house on articles of general consumption. Of course, as population goes on increasing, and the Customs duties remains unchanged, the revenue derived from that source should augment in proportion to the increase in the number of consumers. But instead of an annual increase, there is an annual falling off. In 1867 the Custom-house collected £200,832; in 1866 it was £230,134; and in 1865 it was £240,183. Even in 1864 more money was derived from the Custom-house than in 1867; the large addition to the population over the space of four years failing to yield one shilling of extra revenue as duty on consumable goods. This is a great fact, and one which our readers ought not to ignore nor treat lightly. As regards the sale of Crown-lands, it is less a test of the condition of the great body of the people at any given time than of the amount of available capital in the hands of a section of the community; yet when it is remembered to how great an extent successive Governments have relied upon their territorial revenue, not only for public works and improvements, but also for meeting liabilities arising from the bonded debt, the falling off in this source of revenue is alike significant and ominous. In 1863 the sales of Crown-lands yielded £184,414; in 1864 they yielded £256,672; in 1865 they reached the immense sum of £504,677; in 1866 they realised £331,285; whereas in 1867 they sunk to £171,763. On rents of Crown-lands and assessments there was a deficiency last year of over £50,000, as compared with the returns of the year preceding, and there are other items of minor amount.

Squatting in South Australia.—A South Australian paper says:—"The 'shepherd kings' of a few years ago are tottering on their rustic thrones. The great depreciation in the value of cattle and sheep, and the superadded affliction of a depressed wool market, are telling on the squatocracy, and the troubles of some of them are culminating in a financial collapse. The names of several (and some of whom may be classed amongst the pioneers of the colony) have been upon men's tongues for the past few weeks, and as the last efforts at compromise fail, and the banker becomes finally inexorable, they one by one succumb. When squatters decline, stock and station agents are naturally found to be affected with the same complaint, and hence we hear with regret of houses who have for many years commanded the confidence and esteem of an extensive connexion being brought down in the fall of some of their principals, in whose successes or failures they were too intimately bound up."

## Publications Issued.

Idylls of the King.—By A. Tennyson (*Moxon and Company*). Chromo-lithographs of nine original drawings, by Gustave Doré, illustrating Tennyson's Poem of "Elaine," have just been issued by this firm. Although called chromo-lithographs, in strictness the term is scarcely applicable to this class of printing. The pictures are reproduced after the manner of chromo-lithographs by a series of stones, but in neutral tint of varied character of light and shade. The original drawings themselves are to be distributed to subscribers by lot, as in the Art Union.

## Notes.

Production and Consumption. — A letter on currency, by Frederick Scheer, quoted in the *Produce Markets Review*, says:—"The progress of civilisation discloses mankind under new and unexpected aspects. Rightly considered, it would appear that all men might produce —and vast numbers do produce—a great deal more than they consume; hence the vast accumulation of property. Mutual assistance, designedly given in private or public enterprises — or, unconsciously, as in large cities or communities, further enlarges the powers of production. Consumption, on the other hand, proceeds on different principles. No individual can, in his own person, consume much more than another. No one can eat more than one dinner, and a few accessory meals in a day nor wear out more than two or three suits of clothes in a year. Beyond that, setting aside waste (not very common in civilised society), expenditure implies the maintenance of others, useless or otherwise, as the case may be. The tendency of civilisation, again, is less towards the useless than the useful maintenance of others. An African petty sovereign will have his thousands of attendants, his harem of five thousand black beauties, his herds of slaves, executioners, and the like, deemed necessary to his regal state. In wasteful expenditure he outstrips the sovereigns of more civilised nations. The wealth and influence of the latter are used for better purposes, and progressively more so. Men of station and rank now lead the way in great and useful enterprises, and devote their time and means to beneficial purposes. They have greater satisfaction, we may suppose, in erecting a bridge, or constructing a railway, than in building a palace. Such is pre-eminently the case in England. Thus we might say, that whilst production leads towards constant extension, consumption diverges in the opposite direction of curtailment. There is another feature of civilisation to be noticed, namely, the vast amount of enterprise promoted by association. These associations have a tendency towards a kind of healthy communism, allowing every man, according to his means, to partake of the profits of every kind of enterprise, and turning the community gradually into a species of mutual aid and general assurance society satisfactory to everyone, and without danger, rather replete with security to the State."

The Mont Cenis Tunnel.—During the first fortnight in June the progress made at the Mont Cenis tunnel was as follows:—

| | Metres. |
|---|---|
| Length driven at Bardonnèche end .... | 26·70 |
| „ Modane „ .... | 27·45 |
| | 54·15 |

The position of the works up to 16th June was:—

| | |
|---|---|
| Advancement at south end ........ | 5,045·10 |
| „ north „ ........ | 3,453·05 |
| Total length driven to 16th June.... | 8,498·15 |
| Length remaining to be driven...... | 3,721·85 |
| Total length of tunnel ............ | 12,220·00 |

## Correspondence.

Dynamite.—Sir,—Some brilliant experiments have been lately made at the Merstham Quarries, Redhill, with Mr. Nobel's new explosive compound, a modification of nitro-glycerine; but as fine gravel is used as one of the ingredients, it cannot be adopted for fire-arms. White gunpowder possesses all the properties said to belong to dynamite, and can be made at little more than half the cost, besides being admirably adapted for every variety of fire-arm. It is perfectly clean, leaves no deposit, and can be stored and transported with absolute safety. It requires no granulation or any expensive process in its manufacture, a common flour-mill with dresser being all that is required. When fired in the open-air it does not explode, but merely deflagrates, and,

the combustion being imperfect, some small deposit is visible; but when fired in a close chamber the combustion is so perfect that every particle is dissipated, and the barrel remains absolutely clean after any number of shots.—I am, &c., Henry W. Reveley.

## PARLIAMENTARY REPORTS.

### SESSIONAL PRINTED PAPERS.

Par. Numb. *Delivered on 20th July*, 1868.

382. Volunteers (Maximum Establishment, &c.)—Returns.
395. Tea, Coffee, &c.—Returns.
420. Malt Tax - Report.
426. Education (Ireland)—Annual Report.
435 (I.) Electric Telegraphs Bill - Minutes of Proceedings.

Public General Acts—Cap. 41 to 57.

*Delivered on 21st July*, 1868.

241. Bill—Expiring Laws Continuance (corrected copy).
243. „ Election Petitions and Corrupt Practices at Elections (as amended on re-commitment).
246. „ District Church Tithes Act Amendment.
247. „ Saint Mary Somerset's Church, London (as amended by the Select Committee).
421. County Financial Arrangements—Report from the Select Committee.
431. Brazil and River Plate Mails—Contract.
434. Poor Law (Strand Union)—Correspondence.

*Delivered on 22nd July*, 1868.

248. Bill—Registration (Ireland) (amended).
399. Thames Embankment and Horse Guards-street—Report and Plan.
402. Sale of Liquors on Sunday Bill—Special Report.
413. Vessels—Return.
430. Public Income and Expenditure—Account.
432. Scientific Instruction—Report.

Public General Acts—Cap. 58 to 63.

*Delivered on 23rd July*, 1868.

245. Bill—Schools and Training Factories (Ireland).
249. „ West Indies Bill—Lords Amendments.
250. „ Marriages Validity (Blakedown).
441. Married Women's Property Bill—Special Report.

Education—Report of the Committee of Council.

*Delivered on 24th July*, 1868.

251. Bill—Burials (Ireland) (Lords Amendments).
252. „ Bankruptcy Act Amendment (Lords Amendments).
253. „ Ecclesiastical Commissioners (Lords Amendments).
378. Excise and Customs (Ireland)—Return.
412. Army—Return.
418. Naval Prize Money, &c.—Account.
424. Inhabited House Duty (Metropolis)—Return.
0·113. Parochial Assessments—Lords Report (Session 1850).

*Delivered on 25th July*, 1868.

303. (I.) Metropolitan Foreign Cattle Market Bill—Index to Reports.
344. (A 1.) Poor Rates and Pauperism—Return (A) (May, 1867 and 1868).
422. Wexford Lunatic Asylum—Return.
449. Civil List Pensions—List.

Technical Instruction Commission—Abstract of Evidence.

*Delivered on 27th July*, 1868.

439. Queen Anne's Bounty Board—Report.
459. Royal Gun Factories—Report and Evidence.

Public Petitions—Thirty-second Report.

## Patents.

*From Commissioners of Patents' Journal, July 24.*

### Grants of Provisional Protection.

Aëronautical apparatus—2162—J. Livchak.
Aluminium, producing alloys from—2137—E. H. Newby.
Armour for vessels of war, &c.—2192—G. Davies.
Barometers, &c.—2119—A. M. Clark.
Baths, zincing, construction of—1952—J. H. Johnson.
Boilers, preventing incrustation in—1801—E. P. H. Vaughan.
Boots and shoes—2151—T. J. Mayall.
Boots and shoes, ornamenting—2113—E. J. Scott.
Boots, &c., fastening for—2140—A. M. Clark.
Bottles—2105—C. F. Crailsheim.
Bricks, &c., apparatus for making—2111—J. D. Pinfold.
Bridges - 2123—J. H. Johnson.
Bungs or corks—2196—T. King.
Cane juice, &c., treating—2144—A. Fryer.
Cartridges—2009—E. T. Hughes.
Carts—2121—A. F. Robertson.
Chain stoppers, marine—2055—T. Winder.
Coal, crushing and washing—2168—E. Coppée.
Coke furnaces—2152—E. Coppée.
Driving bands, joining—2156—B. P. Walker.
Driving bands, treating—2153—F. Veith.
Dyeing—2148—G. Davies.
Fabric, manufacturing a new—2117—E. Pavy.
Fabrics and yarns, dyeing—2078—W. R. Lake.
File-cutting machines—2200—H. Garside.
Fire grates and fenders—2158—G. Morton.
Flax, &c., dressing—1979—T. C. Hide.
Fluid meters—2079—S. Hannah.
Furnace grates—2133—J. Head.
Furnaces for calcining ores, &c.—2129—J. B. Brown.
Furnaces, &c.—2115—D. Hall.
Grain, &c, drying—2176—W. Creasy.
Horse collars, &c.—2180—T. Nuttall.
Hot-air engines—2190—J. D. Churchill.
Kilns—2097—W. Daglish.
Liquid meters—2103—W. Brookes.
Liquids, evaporating and condensing—2166—W. Brookes.
Locomotive engines—2145—G Davies.
Locomotive engines, &c.—2107—A. Alexander.
Looms—2110—W. Dean and R. Andrew.
Metals, shaping—1871—A. M. Clark.
Mills for grinding or mixing colours—2208—G. R. Mather.
Motive-power, economising—2027—D. M. Giacometti.
Motive-power, obtaining and applying—1713—A. M. Clark.
Neck-ties, &c.—2106—A. Taylor.
Pavements, wooden—2186—E. T. Hughes.
Preserves, &c., receptacles for—2131 M. Henry.
Printing or endorsing, apparatus for—2204—G. B. Puricelli.
Railway waggons and trucks—2109—H. H. Henson.
Railways—2210—W. R. Lake.
Railways, communication between guards, passengers, &c., on—2127—G. Bennett and J. Woodcock.
Saddle pads, &c.—2147—J. H. Whitehead.
Sewing machines—2143—P. Jensen.
Ships' compasses—2135—A. Albini.
Slate, &c., apparatus for cutting—2198—J. D. Brunton.
Steam engines—2101—W. Brookes.
Stereotype plates—2150—G. R. Wilson.
Swimming apparatus—2178—J. Mabson.
Syringes—2202—J. N. Willis, jun., and S. Judd, jun.
Tanning matters, refuse, utilising for dyeing purposes—2042—E. Mucklow.
Telegraph cables—2160—T. J. Mayall.
Telegraphic apparatus—1840—M. Theiler.
Thrashing machines—2001—J. Bonnall.
Tickets, &c., apparatus for containing and delivering—2172—M. Bebro.
Tobacco pipes—2125—A. Kane.
Tobacco, twisting—2099—R. Ward.
Toy guns—2083—H. Jewitt.
Water, preventing waste from pipes, &c.—2174—J. Chandler.
Yarn and thread, treating—2194—T. Travis, W. H. Prince, and J. Tomlinson.

### Invention with Complete Specification Filed.

Silk, &c., cleaning and finishing—2286—T. Kohn.

### Patents Sealed.

| | |
|---|---|
| 261. C. W. Dixon. | 374. J. Lewis & R. & E. Alston. |
| 274. A. Middlemist. | 440. N. C. Szerelmey. |
| 276. J. J. Hicks. | 450. A. M. Clark. |
| 285. W. Tranter. | 452. H. Schlotter. |
| 290. W. H. Crispin. | 480. H. B Condy. |
| 298. J. Brown. | 490. F. Tolhausen. |
| 311. D. Law and J. Wharrie. | 553. W. R. Lake. |
| 315. S. M. Martin & S. A. Varley. | 664. W. E. Newton. |
| 333. A. M. Clark. | 1090. M. Hawthornthwaite and T. Abbott. |
| 335. E. Fleet. | 1162. A. V. Newton. |
| 341. J. Mitchell, jun., and G. T. Graham. | 1351. J. Dewar. |
| 345. J. Livesey. | 1363. R. Cocker. |
| 354. A. M. Clark. | 1628. J. Mitchell. |
| 361. M. A. Wilson. | 1736. B. Burton. |

*From Commissioners of Patents' Journal, July 28.*

### Patents Sealed.

| | |
|---|---|
| 310. W. Tasker. | 426. T. Walker. |
| 318. J. H. Johnson. | 475. R. Young. |
| 321. J. Radcliffe. | 525. J. Walker. |
| 325. W. Hartnell & S. Guthrie. | 665. W. E. Newton. |
| 326. E. T. Mainwaring. | 667. J. H. Bass. |
| 327. T. Rowan. | 769. A. V. Newton. |
| 340. H. Chapman. | 913. J. M. Elre. |
| 343. G. L. Scott. | 942. L. Encausse. |
| 344. S. E. Howell. | 1309. H. Howse. |
| 348. G. Clarke. | 1485. A. C. Henderson. |
| 353. A. Clark & A. Van Winkle. | 1535. A. M Dix. |
| 382. T. Scott and R. Mowat. | 1615. G. Price. |
| 384. J. Webster. | 1662. C. Barnard. |
| 388. R. D. McKellen. | 1761. T. Greenwood. |
| 396. H. Moore and J. Hamilton. | 1763. J. R. Hambling. |
| 408. G. F. Bradbury and T. Chadwick. | 1947. W. Leonard. |

### Patents on which the Stamp Duty of £50 has been paid.

| | |
|---|---|
| 1921. R. A. Brooman. | 1975. J. Ramsbottom. |
| 2002. W. W. Burdon. | 2093. W. Betts. |

### Patents on which the Stamp Duty of £100 has been Paid.

| | |
|---|---|
| 1830. R. Thatcher. | 1879. J. H. Johnson. |
| 1846. R. Thompson. | 1902. J. M. Hart. |
| 1899. T. S. Cressey. | |